THE ELEMENTS OF WATER-DRAWING,

OR A

Compendious abstract of all sorts and kinds of Water-Machins or Gins, used or practised in the World, with their natural grounds and reasons, and what service may be expected from them.

As also new and exquisite ways and Machins never before published.

With a Philosophical discourse, and new discovery of drawing water out of great deeps by fier.

Where is also disapproved

The perpetual motion,
The Water-poise,
The Syphon or Philosophers Engine,
The Horizontal sails.

With divers other experiments.

Published for the improving the service of the Mineral World, for supplying our most necessary wants of firing, for raising of water for Cities and Towns, and for watering and draining of Grounds.

Ex paucis dictis intendere plurima possis.

LONDON,
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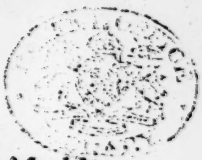
The Preface.



THe *deluſions and fallacies of* Water-Machins *having occaſioned (time after time) not only to* adventurers *in* Mineral *affairs, but to others, ſo great loſſes and expences both of* time *and* treaſure *I have often much wondered, that there hath been ſo little (if any thing) come to publick view of that Subject.*

I know that there are extant, and that in divers Languages, large *and* voluminous *tracts of* Mechanical powers *and* motions, *and of the innumerable ſhapes, and various forms and faſhions of* Water-Gins *(moſt of them to little, if not to bad purpoſe, ſeeing they have not only occaſioned the vain expence of much* time *and* mony, *but often likewiſe the overthrow of the work) but few or none of them (I am ſure in our native Language) have diſcourſed of their* impoſtures, deficiencies, fallacies, *and extent of their ſervice, and what maybe expected from them (or however but ſlightly touched at.)*

Dr. Wilkins *having moſt accurately, learnedly and excellently already treated (in our vulgar tongue) of the chief* grounds *and* deluſions *of* Mechanical Motions *and* Powers, *of the Machins and* Inſtruments *moveing and commanding the* water *and* weight, *but hath (as I remember) taken little notice of the* Water-Gins *or* Machins *moved, bearing and bringing up the* water *or* weight.

Which

Which hath moved me (though most unfit , as being more generally and also too too much accustomed , more to Action *than* Speculation *) to put in view (for the benefit of others) some* observations *and* experiments *(such as you shall scarce find in books) which I have in the course of some affairs taken notice of, and which I hope will provoke some others to declare their* experiments, *whether* reall *or* fallacious, *that they may be as* Sea-marks *to keep those that come after from* Ship-wrack; *false wayes being known and discovered , the right and true will sooner and easier be* manifested ; *which would not only tend much to charity , in saving hereafter the expence of much* time *and* treasure , *which is the ruine of many , but likewise it would very much advance the* mineral World *to a higher perfection.*

Its true , there are divers wayes to attain to knowledge in a science , as reading the best Authors , *converſing with the eminenteſt men in that* faculty, *with a diligent ſtrict and diving (not ſuperficial and floting)* observation *and* inquiſition *in them , but the beſt is (the other being but weak and handmayd unto it)* practice *and* experience. *And* experiments *of this nature commonly being ſo extream chargeable and* expenſive , *that if the firſt fail , many are not able , others are not willing to try* freſh : *for though there have been and are many of the* Nobility *and* Gentry *much* intereſſed *and* engaged *in affairs of this nature (as being honeſt and certainly gainful if well underſtood , otherwiſe expenſive and dangerous) ſome of which , it may be can without much hurt or damage to them , ſuffer the loſſe of an experiment but all that Act , or that are willing or* neceſſitated *to*

deal

deal in these matter, can not so easily rub it off, without great prejudice and damage to them (which is not only a great determent to others: but likewise a great scandal to the mineral Kingdome.)

I have known some experiments and those of no small expence, that have been lately tryed, which have formerly long since been experimented by others, and have failed, which if they had been published or otherwise communicated, might have saved the latter much treasure and time, who might also have spent that time and mony, in some other and more profitable discovery and experiments, and so in a short space have arrived to some greater perfection, by running through by a strict examination, the whole body (as it were) of Machins and other mineral affairs, as also a certain and firm knowledge of their fallacies and defects.

Practice and Experience either by a mans self or by others, is the life and soul of all, it produceth a firm and solid reason in man, upon which are grounded all our elections and avoidances, why such things are to be elected, others to be rejected, the want of which hath occasioned many and great losses. It begetteth prudence in men, which is the superintendent and guide of all other virtues, they being but (as it were) statues without it.

But where all the foresaid means concur, then Titianus fecit, and such (with due circumspection and care) may seldome lose (I mean by the usual contingents and casualties of mines, unless it be by other collateral accidents, which are incident as well to all other Sublunaries, as to Minerals) Casual things, the casualty being taken off, prove excellent.

I knew a young Gentleman, *a friend of mine* (*being not himself versed that way, being disposed for other* Studies) *by the* perswasion *of some of his near relations,* adventured *in that way* (*through the skill of a meer* Scholar) *which trusting too much to his* Theory, *without* practical experience, *received* (*with himself also*) *a great* foyl, *by the losse of many* hundreds *of pounds, which a meer* practical *man, might as easily have gained, upon which score there have many* thousands *of pounds been lost. Vnexspected accidents* surprising *such* (*who notwithstanding conceive themselves prepared against all* events, *warranting their* Skill *by their* reading) *makes them* amazed, *astonished, and even* confounded, *till destruction seize on them; indeed sometimes some unlook'd for* chances *may* surpise *and arrest the most knowing and best* experienced, *neither will their* experience *privilege them from such* casualties, *neither can humane nature be so* omniscient, *but that their skill may be posed,* (*put the most knowing mans* Ignorance *in one scale and his* Knowledge *in the other, his* Ignorance *will infinite-out-*ballance *his knowledge*) *a* minute *sometimes producing what an* age *hath not done before; But then they have this* advantage, *that finding themselves at a fault* (*like skilfull hunters*) *they can soonest know where and how to beat about to recover it.*

But without this experience, especially in these affairs, a man can not easily discern, *what is good and* substantial, *from the tricks of* Tumblers, *matters of strangeness without* worthynesse, *neither can he know* Sophisters *nor deluding cheating* Impostors (*for such he shall often meet with*) *which will distract and tosse him from one thing*

to

to another, drawing him from experiences *to conjectures, from ſerious things to* toyes, *and from events to* gueſſes.

I have omitted ſchemes (my intendment herein being chiefly and principally concerning the rational *part of* Water-Machins *) they being likewiſe not only plentiful in other* books, *but alſo the* Machins *themſelves are ordinarily uſed and* commonly practiced *in many places, which are more* inſtructive *and* demonſtrative, *than the ſmall* models *and* pictures *in books; The others (though not uſual and common) being aptly* deſcribed, *eſpecially to thoſe that have but a little inſight in theſe matters.*

I hope theſe beginnings (though weak and rude) will animate others of better accompliſhments *and* experience, *to farther* diſcoveries, which is the earneſt deſire of

R. D'acres.

ERRATA.

Pag. 4. lin. 33. (*many*) left out before philoſophy. li. 24. (*proſit*) left out, to come in after others at the end of parenth. p. 5 l. 1 (*things*) for artings. lin. 29. (*Philoſo. Ingeon*) for Philo. Jug. p. 6. l. 2. (*experiment*) for eperiment. p. 8. l. 35. (*air imaged*) for inaged. pag. 12. l. 8. (*which ſion*) for while ſome cauſeth wearineſs. pag. 17. l. 13. (*beach*) for beam. pag. 18. l. 19. (*as*) is left out before in ſcrewes. p. 19. l. 26. (*elixar*) for elixars. pag. 20. l. 32. (*Dædalus*) for Dædales. pag. 24. l. 19. (*without*) for with a ſucker. pag. 33. lin. 26. (*if*) for of. pag. 40. li. 34. (*and*) left out.

The First BOOK OF *EFFICIENT MOVERS.*

CHAP. I.

Of the various Species, or differing sorts of Movers.

THose variety of things considerable in drawing *water* out of *deeps* will fall under these two *Heads*; As they belong to the *Machines* moving, and commanding the *weight*; or as they appertain to the *Machines* bearing, and bringing up the *water* or *weight*; the *instruments* and power moving, or the *Machines* and weight moved.

There belongeth to the *Machines* moving, both *natural* and *artificial* assistances, the one as *Efficients*, the other as their *Instruments*.

Natural Efficient Movers are either *animate*, or *inanimate*

mate Creatures. The *Animate* and living *movers* used in this service, are both *rational* and *irrational*, as men or beasts; the *Inanimate* and liveleſſe *movers* are the four *Elements.*

Artificial Aſſiſtances or *Inſtruments moving* are anſwerable, and according to the *natural movers*, which are firſt in Order of *time*, and alſo of *place.*

CHAP. II.

Of natural Efficient Movers, their eſtimate in ſervice.

OF *natural* things giving ſtrength to effect *motion* upon an heavy *body*, the *Elements* as they are firſt in order of *time*, ſo they are beſt in this ſervice of *water drawing*: They are of greateſt ſtrength and matchableneſſe where they can be attained, being of the ſame *rank* with whom (in this imployment) they have to deal; and therefore are moſt *performing*, leaſt ſubject to *tiring*, of eaſieſt *keeping* (as wanting conſuming vitals, which exact coſtly and chargeable *repairings*, feeding only upon themſelves.)

Animate movers are unequally matched in drawing of *dead*, and therefore *heavy waters*; whereby they prove inſtantly weak, infirm, and thence *tire.* They are worthier of ſervice more appropriate to their *Natures*; therefore if you this way force and ſtrain them, you ſhall find them (in all reſpects) *coſtlieſt*: And of them the *rational* and beſt in *dignity*, you ſhall find the worſt in *politie*: you ſhall find man to ſell you his *reaſon* at unreaſonable *rates*: for as he knowes how to do you good, ſo he will want *power* and *will*, to any thing, but his own eaſe; and knowes thereby both when and how to neceſſitate his ſervice, to mitigate his pains, and aggravate his wages.

The *Irrational brutes* are more ſtrong and innocent, yet ſubject to *tiring*: and (which oft times hurts all ſides) they have not ſenſe enough, to manifeſt (as man can) an unuſual, and unwonted heavineſſe in the *work*, nor obſtinateneſſe enough

nough to ceaſe (as the *Elements* will) when it is above their ſtrength : yet (if they be well accommodated,) they will, for one of them, perform more continuing ſervice than four men.

CHAP. III.

Of Inanimate, and Elementary Movers : And firſt of the uſe of the Element of Fire in this ſervice.

THere are but four received *Principles* or *Elements* moſt free, and effectual for the worlds imployment ; And of theſe, but only two, (viz.) the *Air* and *Water*, that have received any known or worthy *perfection* in this buſineſſe : The other two (viz.) *Fire* and *Earth*, are ſo far from receiving any *perfection* (herein) that they have not (as yet) in theſe parts of the world, found any acceptation.

The *world* hath *doted* upon *Art*, and moſt *Expenſive* skilfull *varieties*, in theſe affaires only. *Covetous man* hath gaped ſo wide at *Pictures*, and ſeeming *reſemblances* of *nature*, that he hath not only *Rackt* his ſenſes, but even *bleared* his *Eyes*, from beholding *cheap* and *gainfull ſubſtances*.

If there be any difference in the neglects of theſe two *Elements*, it is moſt apparent in the *diſ-uſe* of *Fire* ; the moſt ſupream, and otherwiſe moſt *Active* of all the reſt : There's but another *Active principle*, the forward inſinuating *Air* ; which in competition with the Fire, may well be computed *Paſſive*.

The moſt excelling and greateſt aſtoniſhing of all *ſublunary* performances, in giving life and *motion* to Inferiour *Creatures*, the ſame (for ought we can conceive) begins and enJs with *warmth*.

It's this neglected *Fire*, that claimes from man a chief obligement for things (of ſecond *rank*) moſt pleaſing of all *Inanimates* ; *Gold*, *ſilver*, *braſſe*, *iron*, *lead*, *glaſſe*, all which were locked, and hid from the world, till that the all *com-*

manding Fire forced them to appear pure, from their *superfluities* and *Impure Graves.*

This Element doth not oppose our affaires, but agrees thereunto: *warmth* being not without *dryneſſe*, kindly imbraceth *moiſture*; and *water* being not without *coldneſſe*, is ready to leave the loathed *earth* to salute the *heat*. Besides all this, the *Fire*'s high, and stately residence, inables most his *power* to force the flying *water* to attend his *Courts*: And those his stately *manſions* in not permitting residence to *vital Creatures*, ingageth his greater furtherance to support them in their own *subſiſting places*: It's equal that he should at least supply his own *defects*, to us, who want so oft his heat: which he may fitly do, by laying *drye* such *Combuſtible materials*, as will assimulate his own refreshing *warmth*: what's all this, grounds of expectation, and nothing *Acted*? will none begin? have we no *patterns*, no *models*? yes, too good, if not too *great*: The most perspicuous *heavens* have with this *Agency* drawn *worlds* of *water* to extreamest heights, even from its *Infancy* unto this present day, and never failed but once, and then not by *defect*, but in a dutious *reſpect* to him, to whom the whole performance appertaines; and this surceasing, it soon with doubled strength regained, and with observant care exhausts superfluous moisture from the surcharged *Earth*. Here the thing is done, lets see if it be in great things, *ſpecious*, the small fail us in the *extenſions*; *Giant like Ofsprings* in the *Cradle*, prove but (too often) *Pygmies* in the *Saddle*; but we are secured here from this *Charibdis*, we coast too much on *Scylla* rather.

Our *Patterns* of immense (yet true) *Proportions*; A safer side; from *great* to *leſſer Actings*, we rarely meet with *failings*. Can not *Natures* plain and spatious open steps be travelled in, in open *Aires*, as well as in obscured smoaks of most mysterious wandrings? Hath not the Philoso, hical *Chymiſt* doting (to no purpose of his own, yet much to others) *extracted* in this *Cœleſtial* manner, not *fluid water* only, but even Airy Juice and Oyl from most *Terreſtrial bodies*? In which *performings* (it may be) if he had left the *matter* and fallen upon

upon the *manner* of thoſe *fiery Artings*, the *world*(ere now) might have been poſſeſt with a Jewel, more uſeful than the ſtone, or rather *Rock*, ſo many have ſuffered Shipwrack on.

To come more near; Doubtleſſe moſt *Diſtillatory* veſſels are perfect *patterns* of theſe *Cæleſtial* performings, ſuch alſo are thoſe *weather Glaſſes*, only ſomewhat *extream* upon the leſſer hand; the beſt and *uſefulleſt mean* for this deſign(I conceive) is between them both; neither want we *materials* for this work; No, we have a *fire* as hot, more preying and thin, more working upon ſurly *water*: VVe have an *Air* as capable of *heat* and *cold*, the Air's as capable of various *forms* and *figures*, as can be deſired. Is not the *Globe* or *Cylinder* the *Airs Region* or place? Is not the narrow ſlender *trunk* the Ray or Beam deſcending to the water? Is not the warmed *Air* there in the Cæleſtial Bucket? Is not the *Air condenſing Cold*, the unwearied *Convoy*?

Theſe *materials* for *quantity* may be Augmented either in *magnitude* or *multitude*; for the *height* deſired is the greateſt matter, that admits exception, becauſe not performed by us to great and high *elevations*; But this will not devoid the *deſign*, for what one will not reach unto, an other may, and ſo mutually imparting the one, unto the other, untill the utmoſt Top be attained: And I am much perſwaded, that the water will not (in this way) aſcend in one length much above ten yards, the reaſon that ſome have rendered for it, is, that the water at that height and ſtrength of motion, will be converted into *Air*, which ſupplying vacuity, the *water* deſiſts to aſcend, as I have perſpicuouſly experienced in that which is uſually called the *Syphon* or *Philoſophers Iug*, and as it is every day to be ſeen in *ſucking Pumps*, whoſe water will not follow the Bucket much abov the ſaid hight; And therefore in great *depths* they are forced to let the *Bucket* down lower into the Pump; but the beſt and moſt natural reaſon (as is conceived,) is, becauſe a column of Air betwixt the Earth and the furthermoſt part of the *Atmoſphere*(or the utmoſt bounds of the vaporous Air, ſo farr as the Clouds do ride, or that the center of gravity extends) doth equi-

ponderate with ſuch a column of water, according to that late experiment of quickſilver, whereby is found that two foot and a half and ſome odd inches of a Tube of quickſilver, equiponderates with 32 feet of water, of the like Tube, and 32 feet of water with ſuch a Column of Air, betwixt the Earth and Atmoſphere. Therefore I ſhall expect no more from it, and can be content with leſſe, and no detraction from the work, for then the veſſels may be every way the larger, being not over preſt with exceſſive weight, and this may very well concur with the nature of the *work*, which requires Intercourſes and ſeveral Ceſſations.

Thus much for the *poſſibility*. The conveniency and *utility* of theſe performings are next to be expected.

For the conveniency, or expeditious *actings* hereof, the beſt and moſt appropriate *Heatings* and *Coolings* are to be choſen, and the moſt ſpeedy applications thereof. The beſt *heating*, is by the incenſed *Air* of a cloſe *furnace*; The ſpeedieſt *Cooling* is by water, which though it be not in it ſelf an *Element* to cool as *Earth* uſually is, nor as *Air* ſome times is, yet it hath a maintaining Coolneſſe, which ſeconds theſe former Acts according to the *quantity* of the adjoyning water, which may eaſily be exceeding much: For the ſpeedier Intercourſe of theſe two *contraries*, the one may be applyed *within ſide*; the other *without ſide* the *Cilinder*, or *Region* of the *Air*: The Cooling water may not enter, for then it neceſſarily fruſtrates the aſcent of the water; the heated *Air* out of the Furnace may enter (by the turning of a Cock) into the *Boul*, and ſo the heat is acted in an inſtant; Then the *materials* and *Globe* being all over head in a *Pond* or *Ciſtern* of water, they (after the heat by the returning of the Cock is diverted) do as ſpeedily cool, and ſo the rarified Air condenſing, the water aſcends, and having a *brazen Sucker* or *Clack* in the bottom, it can not go out again, but then by turning the Cock, the uppermoſt *water* iſſues forth, by the ſucker in the ſpout, which now the deſcending water thruſts open, and in the ſame *Act*, the enflamed *Air* follows after; return the Cock, and the water aſcends as before

fore. Thus the work is expeditious, and two of theſe will maintain a conſtant delivery of water, according to the largeneſſe or number of *Canes* or *Pipes* fixed to the Tun of *Lead*, or *Copper* veſſel, wherein the *Air* is contained.

Apprehend (for the preſent) that the water in thoſe aforeſaid *Actings* is not every time all exhauſted from the bottom, but that it ſtandeth (from below) fully up, unto the *Spout* or delivering place, in manner of a ſucking Pump, by reaſon of one or more *ſuckers* placed in the Cane or *Pipe*; and the condenſing Air, exhauſts it from that level, ſome two or three foot higher, into a bigger bore, or wider barrel, (wherein it neceſſarily liſteth the whole weight from the bottom, as all other *ſucking works* do:) And the water thus raiſed into the wider place, above the ſpout (whoſe ſucker is now drawn cloſe) by the turning of the *fire* Cock, falls violently upon the ſaid *ſucker*, thruſts it open, and iſſuing forth, drawes the inflamed Air after it; ſo that in this Act the venting of the water, and the heating of the *Region*, or *boul*, are both at one time. Neither is there any leſſe time between the *cooling* and *heating*: for when you ceaſe to heat, the cooling begins his drawing, and continues raiſing the water more and more till you give it leave to deſcend forth, by letting in the warm Air; ſo that in all theſe things, as there is not much ſcruple, nor matter of doubt in the thing it ſelf to be made, ſo there is leſſe queſtion to be made of the manner of accompliſhment in a ſerviceable way: Only (as I am apt to perſwade my ſelf) the *deſign* pincheth chiefly, if not ſolely, upon *Utility*: which indeed ought to be the *primum mobile*, and chief end of all ſuch deſignes, (for publick good cannot generally be maintained without *privat profit*) and without which they are like the tricks of *Tumblers*, (matters of *ſtrangeneſſe* without *worthineſſe*.) And it may be that this *politick* reſpect, hath occaſioned the ſuppreſſing of the *work* in long inhabited Lands, where *firing* beares a greater rate, than will be (with profit) afforded: And thence (happily) this *buſineſſe* proves like the Counſell of *Cæſius* the *Phyſician* in *Tiberius* the Emperours time, which was to remedy a general *Head-ach*, cauſed

ſed by ſitting oo near Coal fires (as they conceived;) adviſing them to quench the *Coals* with *Wine*, and then they would prove leſſe hurtfull and offenſive; had our *times* and *Countries* the *wine*, they would warm themſelves firſt therewith, without the fire, though their *heads* ſhould Ake much. Even ſo in our buſineſſe, the *remedy* may be ſuſpected to be worſe than the cure, and we had rather have the fire without the Coals. However men generally (eſpecially being not of a diving Philoſophical ſpirit) are ſoon *terrified* from good (eſpecially firſt) *attempts*, and may not without juſt cauſe ſuſpect the profit of this *work*, in ſome phanſied ſtrange way of Acting the ſame. Yet if this aforeſaid may be rightly apprehended you cannot conceive the charge to be any thing near unto what is commonly defrayed in the motions cauſed by men or horſes: certainly therefore the fuel, nor attendance of this fire cannot be very *expenſive*.

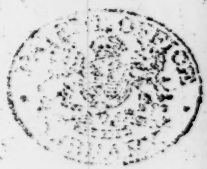
There is alſo another *excellency* (which much mitigates both the charge, and anxious vexations that attend works of this nature) in that the Inſtruments of the work are not in any violent *motion*, and thence break not, nor ſo much decay; for moſt of the *Inſtruments* are fixed, and move not. The *Fire* and *Water* (mainly) are the buſie *bodies*. The ſtanding Charge of Erecting this work, will not much exceed the charge of thoſe we uſe: and it will alwayes be accommodated to crooked, narrow, ſmall *pits* and places, where moſt of thoſe the world uſeth cannot. And laſtly, when the *work* is ended, it will return from the *braſſe* or *lead* therein imployed, ſome near proportion of what was firſt expended.

Thus I have ſhewed you what this Element of Fire hath done in great, will do in ſmall, and moſt probably may do in mean proportions.

The *Element* of *Earth*, being a ponderous, heavy body, it may be applyed as *Weights in Jack-work*, or in other *Contrivances*, *&c.*

Air incaged, or *Wind*, hath found ſome *Entertainment* in the world, in divers places; and is experienced to be of great ſtrength, but (together with the *Chargeableneſſe* of the Engine)

gine) hath likewise two great inconveniences in it (which hath made it again not so usefull, so that it finds little or no *acceptance* in the world) *viz.* most violent and unruly gusts, breaking and rending all in pieces, though very strong, and indangering all parts of the *work* wherein it is employed: and otherwhiles that very suddenly lazy *saggings*, and a present total *becalming*; by which *inconstancy*, there is usually little gained thereby, but only a little rest for the cattel, which notwithstanding must be maintained with meat, and always in readineſſe.



Inſtruments peculiar to the *wind* in making *Motions*, are only *ſayles*, as yet in use; and these are of three *ſorts*, differing chiefly in their *poſture* and manner of placing them. The first sort are *hanging down right*, the other set *level*, the 3 sort *screw wayes*. The first sort (being *perpendicular*) are the most usual & best, being commonly used in the Corn mills. The other sort call'd *horizontal ſayles*, are of little use, and leſſe worth; they will move, but not equalling the strength of one *horſe*. Some of these are made to go with *ſhrouds* or *ſhelters*, others without: those without *ſhrouds* give a *broad ſide* to the driving *wind*, and come more closely up against the wind, the sailes falling off at the utmost ends, or closing together; either of these wayes hanging upon *Iron Gimbals*, are subject to sudden breaking in great *winds*; and also indanger the *Gins* set to them by their sudden *Girts* that every sail gives when it takes the *wind* with the *broad ſide*; and are not therefore in use for moving water *Gins*.

The other sort of *Horizontal ſailes* with *ſhrouds*, move more quietly, but with no worthy strength, though the one half be shrouded never so wel, as experience hath taught. The reasons may be these; The commanding *ſayles* in the wind are but two at the most, and but one of them sometimes in full strength. Then on the other side, though the *ſhrouds* may keep blustring *winds* away, yet neither it, nor any thing elſe, can keep the *Air* away, and the sailes coming against it with broad sides, receive thereby such a *check*, as cannot be recovered by the other side.

The third sort of *sailes* are placed *skrew-ways*, upon an *axis* lying *horizontally*, as if *sailes* were fixed upon such an *axis* as a *shaft* of a wheel, (a little winding about the *axis* like a skrew, but not much) the whole length of the *axis*, so that which way soever the *wind* cometh, except upon the two *points* or ends of the *axis*, the *sailes* are in a readinesse to receive it; all the nether part of it from the *Center* of the *axis* downwards is shrouded, as the *horizontal sailes*. These (as some conceive) perform better service than the *horizontal sailes*, but not so much as the *perpendicular*.

The *water-Gins* or Mills, having been many ages used, and almost every where practised (though not as yet commonly brought to their utmost perfection) where they can procure the advantage of the *water*; yet not so *advantagious* for the *mineral* affaires (especially if of any depth, and much *watered*) as some have conceived; not only in regard of the great quantity of *water* that they require for their *maintenance*, but likewise there must be a constant supply of that quantity for the mineral work, which few *rivers* affords, and but few houres in a day, for that *weak work* of grinding (I mean in comparison of the other.) The Meal man or Miller, his water being spent, can stay his corn untill he hath a New supply, so cannot the *Mineralist*, he must supply his *strength* with *Animate Creatures*, (viz.) with horses, or other living creatures, which alwayes must be at *hand* and ready, otherwise all will be *drowned*. Thus have I for the present done with *Efficient Movers*, I come now to *Instrumental Movers*.

The

THE SECOND PART OF INSTRUMENTAL MOVERS.

CHAP. I.

Of Inſtruments ſerving to Animate Movers.

THe *Artificial Inſtruments* moving the *water-Machine* are many, anſwerable unto the *Natural Principles cauſing* the *motions*, whereof accordingly, ſerving to *mens* labour in *drawing water*, are *Inſtruments* fitted both to their *hands*, and alſo to their *feet*.

To mens *hands* are commonly fitted *ſweapes* and *winches*; the firſt are eſteemed beſt, and moſt in uſe, and they are diſpoſed either *horizontally* or *perpendicularly*. Thoſe that are *moved* to and fro, men cannot ſo well command with that free and full ſtrength, as they may the *perpendicular ſweaps* which move up and down, as hath been experienced in divers places of this Nation.

Winches or *Cranks* of *Wood* or *Iron* are alſo fitted to mens hands, thereby to make a *round motion*. This motion goeth ſo hard and *ſore* with *men* (as alſo with other *Animate Movers*) they cannot well abide it long. The *Circu-*

lar and *round* moving of their *Arms* and quickneſſe required withall, taketh them from their *wind* and *breath*; beſides, there being an inequality of ſtrength in the *Armes* in relation to the poſture, they being ſtreight and at full length, have greater *power*, *force*, and *ſtrength*, to pull to him, to put or thruſt from him, than when they be in a bending and crooked *form*, which occaſioneth *Ierks* and *ſnatches*, while ſome cauſeth *wearineſs*: ſome little help is added hereunto by *addition* of a *ſuperfluous heavy ſwey*, voluble voluntary *wheel*, as ſome call it, which being more in *weight* than the *water* will (being once ſet a moving) help the *work* for a little ſhort ſpace; but then it muſt be anſwered again, with renewed ſtrength, or elſe it preſently deſiſts.

There are fitted to the *feet* of *men*, divers *Inſtruments*, as *Treddles* (as ſome call them) inſtead of *ſweaps* to his *hands*; but they cannot in this way perform any great or worthy ſervice; by reaſon that their *feet* will not permit ſo long a *ſtronk* as their *hands*.

There are more properly fitted to *mens feet*, certain great *hollow wheels*, hanging *perpendicularly*, in which men tread (called by ſome tread-wheels) not unlike unto a dog in a *ſpit-wheel*; men in theſe perform good ſervice in *round motions*, by reaſon that they imploy therein their whole *weight*; But they perform not ſo much in this or any other way, as hath been expected, not in any near propottion equalling the ſervice of *Cattel*.

Inſtruments accommodated to *Cattel* and brute *beaſts* in *water drawing*, are either ſuch as are immediately fixed to the *beaſts* to carry with them, or ſuch as the *beaſts* are faſtned unto, to draw after them; The firſt ſort, are common with thoſe that are uſed in other ſervices. Only in theſe ſorer labours, they muſt be ſpecial good and eaſie, with ſupply of *freſh* and new upon any occaſion. The *walk* or *gate* wherein *Cattel* work is beſt that moſt agreeth with their natural *goings* (*viz.*) neareſt unto *ſtrait* and *ſlow*; for a *place* too round takes off (as it were) their inmoſt

legs

legs, and an over ſpeedy pace, takes off firſt their *wind* and thence their ſtrength and health.

Inſtruments whereunto *Cattel* are *faſtened*, and other brute beaſts in water drawing are common (for the moſt part) with thoſe that are uſed in diverſe *Inanimate movers*; And of theſe in the next Chapter.

Chap. 2.

Of Inſtruments ſerving indifferently both to Animate and Inanimate Movers.

THe *Inſtruments* promiſcuouſly ſerving both unto *living*, and alſo unto *dead Creatures*, cauſing *motions*, are either more uſual and near at hand, or leſſe uſual and more *remote*.

The firſt, are chiefly *great wooden wheels* with *Coggs* in them, working *Trundles* with round ſtaves in them.

Theſe wheeles have their Coggs placed, either upon their utmoſt verge or *Rimb*, and hang *perpendicularly* for the moſt part; Or elſe have their Coggs on the upper or lower ſide of the ſaid Rimb, and theſe wheels hang either *Horizontally* or *perpendicularly*.

The firſt ſort, are leaſt in practice, becauſe they receive not eaſily ſo true a pitch as the other, and will (at the *extremeſt end*) ſooneſt wear out of *pitch*, whereby the work with move *falſly*, and ſo conſequently more heavyly.

The other way of Cogging the wheeles either *upward* or *downward* are both alike in ſervice, and are to be embraced according to the beſt conveniency of the *Place* and *Room* permitting, whereby the *weight moved* may moſt conſtantly, ſteddily, and ſtrongly, ſtand to his mover and power moving.

In theſe wheels this is obſervable; That they be not framed of too ſhort a *Diameter*, for then their (*circumference* will come in too quick a Round, and ſo not carrying

the Trundle before it in a *ſtrait* line, but *twiſtingly*, it will much augment the *weight* of the work, and likewiſe more ſpeedily wear out the Coggs.

Three Coggs (at the leaſt) would be in ſervice at once, one *leaving*, another *taking*, the middlemoſt *fully* upon the *work*; the ſtaves in the Trundles likewiſe muſt not be too few, for ſtarting the *work* (as *Mechanicks* ſpeak) and thoſe (whom providence hath caſt upon theſe affairs) muſt condeſcend and apply themſelves to know the *terms*, *language*, and *practical* wayes of workmen, otherwiſe they ſhall not ſo eaſily attain to ſuch an underſtanding in thoſe affairs as is requiſite; *Ignoratis terminis ignoratur ars*; The terms being not underſtood, the art is not underſtood; which if the *maſter adventurer*, or *Lord* of the *field* (as ſome call him) hath not in himſelf (or by ſome faithful knowing-man) a *knowledge* in them, he cannot rightly *deſign* and *caſt things* for the beſt *advantage*, neither ſhall he be able to underſtand, nor receive the beſt *advice* and *Judgement* of others when given; he muſt likewiſe ſeldom or never expect much to be *enriched* by them, but the *contrary*, (eſpecially if it be a work of difficulty or danger) this is one chief cauſe (amongſt others) which hath occaſioned ſo many, and ſuch vaſt ſums to be loſt that way, and which brings a man to a *non putarem* (this is *digreſſion*) But to our purpoſe again; They muſt alſo have ſome anſwerableneſſe and proportion to the *weight moved*, or elſe if they be too much under it, they will wear too faſt out, and be very often out of frame and order. But this Art hath attained a great meaſure of *perfection* both by *Engliſh* and *Dutch men*; And is better *acted* than *expreſſed*.

There is now in uſe a ſaving way (as ſome conceive) by facing one half of the rounds with iron or braſſe plates, but nothing is done to the Coggs; ſome have thought that they may alſo be faced with braſſe plates, when they are worn ſomewhat down to their proper going, (not before) which may be practiced in heavy net *works*, but I ſhould conceive it not ſo neceſſary, in regard the Coggs being

more

more in number by far, than the Rounds, do not ſo faſt wear, and likewiſe when they be worn, they may be eaſily repaired.

The *Inſtruments* more *removed*, and ſerving to moſt *movers* whatſoever, are uſually long *ſhafts* of ſtrong *Timber* grafted one within another, ſet *perpendicularly* down in ſtreight *pits*, or other places, thereby to reach a motion unto the diſtant work. Theſe move at the lower end upon a Center of ſteel, in a ſtop of Iron or Braſſe, full of oyl, tallow, ſope, or tarre, and at the upper end with a ſpindle or gudgeon of Iron in a collar of Braſſe. Theſe ſhafts muſt be very ſtrong, if they be of great length, leſt in their *ſhoggings*, they give a trembling palſie motion, and ſo increaſe much the weight.

If they exceed twenty yards in length, they wou'd then have *Collars* of *Braſſe* in their weakeſt places, and *Rowlers* of *Iron*, thereby to be ſtayed with leaſt hinderance.

There be of late uſe, in crooked and narrow pits (where ſhafts of wood cannot well be placed) certain looſe chains, which work in Grove wheels, after the manner of Jack-Spit Chains, theſe will perform good ſervice, though not ſo well as ſhafts with Cog wheels.

Theſe looſe *Chains* are ſubject to theſe Inconveniences: Firſt, they will break, and ſo fall down, and thereby much hinder the work; Secondly, they will wear themſelves to a greater length in a ſhort ſpace, and muſt therefore be often taken up, which is another hinderance to the work; Thirdly, they will ſecretly ſlip and ſlide, and ſo command not the work with that ſtedfaſtneſſe as is required.

There are many other wayes coming into *practice*, for moving *water-Gins* a great way *diſtance* off from the place of the *mover*.

One is by a great double Rope running within Grove wheels, in manner of a common womans ſpinning wheel.

This performeth ſervice admirable well two hundred yards remote. Theſe hinderances attend theſe Ropes: they being of great value, will in ſhort ſpace be worn out: they

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will also shorten in wet, and lengthen in fair weather.

But were these made to move *forward* and *backward* only, not round about, they might continue longer; and by this motion they may most aptly work *sucking pumps* and forcers. And for their stretching, they may in some convenient place in the way have a great *weight* hung upon the Rope, which shall either give it *liberty*, or keep it strait, as need requireth. This same motion also may effect a giral or turning motion upon a chain pump, by meanes of two half cogged wheels, placed one above, and the other below a *Trundle*; as is performed in divers great works of somewhat differing natures: or it may be converted into a round motion, at the furthermost end, by a swaying weight of equal poise with the work.

This work may without Ropes be effected with *woodden poles* joynted one into the other, to reach a quarter of a mile in length, provided then, that the weight of these poles be taken off by some external meanes, happily by disposing the weight of the poles in divers places, to rest upon narrow moving *Centers*; in which we may see many *Tunns* weight will be with a mans hand turned to and fro which way we please.

This *Instrumental* mover by *poles*, deserves (as by some is conceived) as much *experimental perfection*, as any the world hath yet (in this nature) laboured with. For hereby the strength and service of *Rivers* (which in those Countries are commonly not only very strong, but also very swift by reason of their great falls) too remote from the place where we need them, and which cannot be brought nearer by reason of the *Ascending ground*, may become most commodious to the Mineralists: neither can they be generally addited, soughed or shored, (without infinite charge and time) in regard of the obdurate hardnesse of the rock or stone.

There hath been some yeares since, an experimental Assay made to take off the weight of these poles, by hanging

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ing them in several places, like *Bells* or *weights* at the end of chains; but it being the first experiment of that nature, & (*nihil simul inventum est & perfectum*) nothing (you know) is at once and together invented and perfected, first invent, next amend, and lastly perfect, it happening in such unlucky times, the prime and chief designer and workman being since dead, it was not brought to that wished perfection, as it might have been, in regard of these military discouraging times.

There be many other Instruments waiting upon most motions, as *Cranks* and *Tawmps*, as also the contrivance in that new work in the *Strand*, making steps and notches in a fixed beam, and surrounding the horse Gin sloped for the more facile pulling up of the weights, after their suddain and perpendicular falling down, which weights so falling down ballance up the water in the force work, as may there further be seen, none of which suit well either with Men or *Cattel*, by reason of the *starts*, *jerks*, and *girds*, which living movers will not nor cannot so well endure. The removal of this inconvenience hath been attempted, with voluble moving wheels, but not to full satisfaction.

Some conceive the Tawmps or stops of wood or iron standing forth of the moving Axeltrees, are of better use and service, and doe with lesse inequality give motion, as is commonly seen in Walk-mills, Paper-mills, Iron-mills, smelting-mills, and in divers water Gins, and force works; These also did very conveniently move the poles, in the foresaid experiment.

Concerning these and all other going works, these must be trusted unto as sound principles; The not observance of which, I may safely affirm, hath occasioned most absurd undertakings, and likewise many great losses, (viz.) That what soever we (by the disposure) gain in strength, we lose as much in time, and so the contrary; if you make one pound poyse up twenty or a hundred pounds, it requires twenty or hundred times the space, and so the contrary; so likewise if you dispose a Gin that one horse shall draw

up the weight of ten or twenty horſes, the one horſe muſt be ten or twenty times longer in drawing it up, and ſo you may inſtance *ad infinitum* (this is a great Sophiſm, and uſed much by ſome *Impoſtors*, to thoſe that have not underſtanding in theſe *affairs*, for what *benefit* can be reaped thereby, either in *mineral affairs* or in raiſing water for *Towns*) Otherwiſe the VVorld had been all full of perpetual motions, by this time; And as one ſaith moſt excellently, The works of nature would have been then too much ſubjected to Art, and might be thereby encouraged (with the builders of *Babel*, or the rebel Gyants) to ſuch bold attempts as would not become a created being, and infinite ſuch tranſcendent miracles had been wrought; Therefore the wiſdome of providence hath ſo confined theſe humane Arts, that what any invention hath in the ſtrength of its motion, is abated in the ſlowneſſe of it: And what it hath in the extraordinary quickneſſe of its motion, muſt be allowed for in the great ſtrength that is required unto it, in ſcrews and the like, for if weight, ſtrength and time can be reconciled, a perpetual motion may be aſſerted.

Alſo the ſtrength and laſtingneſſe of it, as alſo the eaſie clever and ſmooth going of it (as workmen term it) together, which is a chief matter to be regarded (that is) the ſimplicity and compendiouſneſſe of its compoſition (*fruſtra fit per plura, quod fieri poteſt per pauciora*) you know, it is in vain to do that by many things, which may be done by few, which is not the ſole advantage that appertains to ſimple and compendious things.

I know it is and hath been the advice of moſt workmen in that nature, to perſwade Gentlemen, with what great eaſe and facility they can make their work to go, by addition of Counter-geere (as they term it) Some out of knavery to make themſelves more needed, and ſo more reſpected, regarded and implyed, and more work; Others out of meer ſimplicity, as being moſt excellent in the manual part, but moſt defective and ignorant in the rational, as it hath too often

often been manifeſt, to the extreme damage of ſome. I confeſſe ſome places are ſuch, that ſuch motions cannot be avoyded, but otherwiſe let them be rejected, for it is ſo farr from adding eaſe, that it doth the contrary, beſide other inconveniences.

Take this for a rule, that in all Water Machines the more ſimple and tending to unity the neareſt to perfection and eaſe, and the more uſefull and leaſt ſubject to be out of order.

CHAP. 3.

Of perpetual Motions.

NOw ſeeing I have ſpoken of perpetual motions, give me leave in the next place to make ſome enquiry, as alſo ſome diſcovery of ſome of the wayes and inſtruments, by which ſome imaginations have by ſome ſeeming probabilities & confident conjectures violently attempted them (which commonly (though not alwayes) is the fate of thoſe that have but ſome ſmattering in theſe Arts, or that are not ſo fully nor ſufficiently grounded in them, which upon better Tryal and experience vanquiſheth) It is, as one ſaith, that great ſecret in Art, which like the Philoſophers ſtone in Nature, and the longitude in the Mathematicks, hath been the buſineſs and ſtudy of many ingenious and refined wits, for divers ages together; And it may be (as I conceive) not only queſtioned but reſolved, whether either of them (as yet) hath ever been diſcovered; yet for the one (*viz.*) the Stone or great Elizar (as ſome call it, I muſt in charity (for the preſent) ſuſpend my Cenſure, there being ſo many, ſo great and large not only dead (*viz.* books) but alſo living teſtimonies of it. Therefore I cannot (I ſay in charity) call it, as one wittily doth *Caſta Meretrix*, a chaſt whore, *quia multos invitat, neminem admittit*, becauſe it allures many, but admits none; as for the other, I

know not (as yet) any ſuch Teſtimony for them.

But firſt let us a little examine what is meant by perpetual motion: which ſo farr (as I conceive) is not intended an everlaſting motion, which is not to be had (preciſely) but in God himſelf; but hereby is intended (as I favorably think) a long continuing ſelf-moving thing, while materials and inſtruments will laſt, and that to be for ſome good ſpace, and afterwards, to admit of eaſie repairs: Which is therefore by the more Judicious called not *motus perennis*, but rather *motus perannis*, a motion holding throughout ſome number of years; and not this neither, (in any manner of wayes) for we need not ſeek farr for that which is in our ſelves, and all animate Creatures during life; And alſo every where found in ſome Elements, as principally (with leaſt art) in the Water, which from continual ſpringings, makes accordingly ſerviceable motions during the extent of materialls; ſo the Fire, in the way already ſpoken of; and ſo the Wind or Air may be in a manner perpetuated; But all theſe require then a ſupply of new movers, as conſtant ſpringings, more fuel, and renewed or conſtant blowings, which are not every where to be had, nor in every mans power to command.

I ſhall now briefly ſhew you, ſome contrivances and inſtruments whereby this continuing ſelf-moving thing as I may call it, hath been attempted, that you may judge of the Lion by his claw, by which alſo you may avoid and cenſure others of the like nature.

There are three manner of wayes, wherein men have buſied themſelves for this contrivance, as Chimical extractions, by magnetal power, and by ſolid weights; for the two formoſt I conceive altogether loſt time and labor to ſpend any time about them, *Of all which ſee Dr. Wilkins Dædales*, but of the third, as being more probable, and ſo more apt to deceive, I ſhall ſay ſomthing.

The common *maze* or *form* wherein *Diſſie Heads* have ſought the *perpetual motion*, hath been in *Circular motions*, (according to that great Philo. *Ariſtotle*, who ſaith, that a

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Circular motion is moſt proper for it,) aſſimulating herein (as one ſaith) not ſo much nature, as their own diſturbed and unſettled reeling Brains.

The *Inſtruments* at hand for this *deſign* have been chiefly *wheels*; *wherein*, and *whereon* they have laid and diſpoſed ſolid weights. The wheels wherein theſe ſolid weights have been placed, have been *Concave*, and hollow in the *Rimb* or *utmoſt* verge, ſome onely in the *ſpoaks*, and ſome in both; for the *weights* being *ſand* or ſmall leaden ſhot to ſift up and down (like a light huſwife) in ſome without ſtops, others with ſtayes, in divers places, ſome with *ſtrait*, others with crooked hollow *ſpokes*: Infinite of wayes have been attempted, both in great and ſmall Models; and we may well believe, that none hath in this way been left without aſſayes, both for materials and forms, but all in vain.

Neither ſeemeth it to me, to carry in it any ſhadow of likelyhood, ever to effect a *perpetual motion* by *inward principles* or movers; wherein we have no imitable preſident in nature that I know of. For grant it may ſo be, that Art can do whatſoever Nature doth, by preciſe treadings in her ſteps, doing the ſame with nature, both for matter and manner; yet in the foreſaid way we have no imitable preſidents. Nothing in nature (as I remember) that moveth for any continuance of time by *internal principles*, but living creatures only, and theſe I count unimitable. The Elements in their own places reſt, out of their places, their motions are but ſhort. A ſtone falling from above is not long a moving; neither is that motion truly natural; for though the nature of the ſtone is heavy, yet for it to fall is accidental, as being occaſioned, from his place: and if this motion be continued, it muſt neceſſarily be forced by outward ſtrength. Indeed vital creatures move from themſelves, but theſe are unimitable both for matter and form. None can make fleſh, nor then infuſe ſpirit or ſoul into it; and if we could, one would prey upon the other, & ſoon decay our new Creation, unleſſe we did maintain it. And if we muſt uphold our new made Creatures with food, we had as good keep theſe we have already

ready made to our hands, wherof we may have freſh ſupplies.

Some have looked for it, in the multiplication of wheels and ſelect order of pullyes, but it hath been long ſince ejected by that foreſaid principle now ſo commonly known and underſtood (*viz.*) that which is gained in time requires the more ſtrength, and ſo the contrary.

Some likewiſe have endeavoured to effect this perpetual motion by fluid *weight*, as *water*, by contriving that the ſame water that aſcends up ſome Gin, by means of a *water-wheel*, ſhould return again, upon the wheel, and ſo move *perpetually*; now the uſual means by which water aſcends in an inſtrument is by forcers, ſuckers, and the like, which requires much more ſtrength to operate, than the ſimple weight of the water. Therefore the moſt probable inſtrument for raiſing water for this purpoſe is that which ſome call *Archimides* ſcrew, Tunn-mill or the water-ſcrew, which hath neither ſuckers nor forcers in it (for the excellency of this engine for ſome purpoſes and for ſmall heights, I ſhall ſay ſomething of it hereafter) but upon tryall and experience, it is found altogether fallacious for the aforeſaid purpoſe; by this *contrivance* many have endeavoured to return the *water of a water mill*, upon the *wheel again*, but with very bad ſucceſſe and profit, they not conſidering, that the bringing back of that water will cauſe the more force of *water* and *weight* to be put upon the *wheel*, and ſo ſpend much more *water* (for the reaſons above ſaid) than that *reverting water* will amount unto. Such will find their beſt *contrivances*, will be (as in other matters) the well *husbanding* of it (as I may call it) before it be ſpent.

Others have proceeded more naturally (as I conceive) by making wheels whereon they have layed their ſolid weights, and ſo have attempted this ſelf-laſting motion by external movers; And theſe have been of two ſorts.

Some of theſe wheels, carried their ſlitting weights about with their Rimb; and were ſo ingeniouſly contrived, that they could take, and leave their burdens (being leaden plummets) when you would in a manner: but becauſe

they

they could (for the measure) carry no more with them than what they left (the time before) behind them, the design fayled, though (for the matter) they did this never so acurately.

Other wheels in this design imployed, have only supported their weights, pressing upon them from above; and this (I conceive) came neareſt the design, for our times have not herein ſo much exceeded the wiſdom of old *Archimedes*, as not to take him along with us; In that he modeſtly affirmed his ability to move the whole world, ſo that he might have a place given him whereon to ſtand, and that apart, and in quiet too (as I conceive) ſome glimps hereof may be ſeen in this deſign, after this manner.

They erect a mighty great *wheel perpendicular wiſe*; equally *poyſed*, the *verge* thereof is full of little *pully* wheels one after another round about, as thick as can be ſet, turning upon little *Axeltrees* moſt eaſily; This wheel is made large, of thirty or forty feet *diameter*, to come thereby (upon the higher part) the nearer to a ſtraight line: in this place is the *external weight* laid, as near againſt the *center* of the wheel, as may be, and not to be directly over it, that ſo it may preſſe the wheel about, and yet the *impoſed weight* not fall down; To this end alſo, is the bottom of this *weight* made of wood, with little wheels running in it, anſwerable to the former, ſo glib and apt to move, as that one paſſeth by another without any *check*. The far end of this *weight* is fixed, and reſts more at quiet, as is required.

It hath been affirmed by ſome, who (as I remember) had ſometimes a hand herein) that this wheel being thus diſpoſed would move of it ſelf, but not to carry any ſtrength with it for ſervice; And that it had alſo this inconvenience attending it; that having the ſame weight preſſing it, the Air adjoyning fleeing from it, and more rarified, every bout was ſpeedier than the other, and ſo in ſmall ſpace, it would run it ſelf to fier; but if this was all the obſtacle, let this motion be produced, and (I do conceive) it might eaſily be regulated; I rather ſuſpect the

dulneſſe

dulneſſe than the unrulineſſe of the Beaſt.

Some have attempted to add eaſe and (ſo conſequently they might have had the *perpetual motion*) by way of *ballancing* or *poyſing* of water, by water or weights, ſo that there would want nothing but the turning of the *ſcales*, by ſome animate *ſtrength*. I have heard of ſome (many years ſince) at firſt apprehenſion of it, ſo extreamly elevated with the ſeeming *probability* and *paſſibility* of that conceit, that they were peremptorily *confident* of it, but they after found the vanity of it; which alſo was further confirmed by an *experiment* of a double *ſucking Pump*, the water being let out of one Tree into the other by means of hollow *Tampions*, placed about the play of the *Buckets*, conceiving by that means, that the water in one Tree would *ballance* up, or at leaſt mitigate the weight of water in the other Tree, and ſo the contrary; The other *experiment* was as I remember, there being three *branches* fixed to a *mayn pipe*, in two of which *branches*, there were two *forcers* with their *Barrel* and *Suckers* above them, the main *pipe* was the third branch with a *ſucker*, intending thereby, that the whole *weight* of the *water* in the main pipe ſhould *poyſe* or *weigh* up a plug, which was fixed to a weight, ſo that the weight of the water might *poyſe* up the *weight*, which *weight* might again ballance up the water in the *mayn pipe*, (as it were by turning of the *ſcales* by the help of ſome ſmall *ſtrength*) and ſo by ſuch and the like projects, thought to have drawn a greater quantity of *water*, by the ſtrength of one *horſe*, than others have formerly with *ten*. The main *fallacy* (as I remember) was, that the receiving and comming in of the water at the *forcers*, took off the weight of the *water* in the *mayn pipe* and weight, *&c.* by which better appeared the vanity of the *water poyſe*.

Thus have I made a ſhort diſcovery of ſome contrivances and attempts to effect a perpetual motion, as a Rock and ſand to be avoyded and ſhunned, not as ſafe deeps to ſayl in, and confided in.

Nothwithſtanding I ſhould be loath (by this diſcourſe)

to

to discourage any mans industry, somewhat to search into
[illegible]
science of Truth, thereby the better to avoid and shun them) but not to wade too deep, but let others sea-marks and harms, be a sufficient warning for thee: for though thou dost not attain to what you seek for (like many, who searching for the stone, though they have not accomplished their end, yet they have found out many excellent and usefull things for the use and comfort of man: so it may fall out in this enquiry, as experimentally I can testifie some have done.

THE THIRD PART OF WATER MACHINS.

CHAP. I.

Of Instruments wherewith water effecteth Motions.

INstruments serving to *water*, in raising of *water*, are either meerly *natural*, or more *Artificial*. The first, have a long time been called the *Syphon* or *Philosophers Engine*, as if there were in them some *mysteries* in *Nature* more than in any other works, because common and vulgar *Apprehensions*, could not (so easily) perceive the nature of their Actings, as they seem to do in other *Machins*. This devise hath long time been, only a kind of a make-sport in the World, and of little or no use (except amongst Vintners) and with which the World hath played, as the Philistins with blinded *Sampson*, laught at him, but durst not come near him, to try his full strength, but in Models, little better than *blindations*, and also most fallacious and sophistical, as hath been too too often found by the expence and losse of much treasure.

It fell to the share of some Acquaintance of mine (though not to their profit) to make a full and compleat tryal of this

(sup-

(ſuppoſed) Giants full ſtrength, vigour, and worth; after many eſſayes in large leaden pipes of three inches bore, and alſo of leſſer ones, it was brought to a diſpoſeable Machin, doing good ſervice for the height that it would draw.

After this manner it was compoſed; At the receiving end next the water, There was placed a forcer, which being wrought upon by mens hands, would preſently raiſe the water up the pipes, which water when once it came to the higheſt places, and began to deſcend, it would then accordingly eaſe the workmen, and when at laſt it was all filled, it would run of it ſelf, whilſt it had water in the Ciſtern to draw at: And if for want thereof, or by any other means, it went out of Order, by the foreſaid means and wayes, it was inſtantly put in tune again. Some likewiſe have placed, not only the receiving end, but likewiſe the delivering end in two Ciſterns full of water, that, by reaſon of which no Air might aſcend the pipe for want of water, neither for want of ſufficient ſupply run it ſelf dry, but alwayes ſtand full, and when ſupply commeth then the water in the Ceſterns to run again, keeping the Air out of the pipe, which cauſeth the parting or breaking of the water in the Machine, and ſo ceaſe to perform its ſervice, (to the leaſt height.) The delivering end alſo muſt hang lower than the receiving end, that it may contain more weight of water in it, to caſt the ſcales: for it is the weight of the water in the delivering ſide, which forceth the Aſcent, and over ballanceth the water in the other ſide.

Beſides the known conditions of this Machine, experience hath found out theſe alſo; That this Machine will not exhauſt water, much above ten yards or thirty ſix feet in height, above which height the water will be converted into Air; but the beſt approved reaſon is, that a Tube of water of 32 feet, doth equiponderate with the like Column of Air betwixt the earth and the Atmoſphere, as you may ſee before in the diſcourſe of ſiſter. Some conceive this Inſtrument, with the ſucking pump alſo, (the natural reaſon

being the same,) might draw higher, if the pipes were right (as they call it) that is, free from letting in Air; but however I do conceive, that there is no matter or metall of which they can be made of, whether wood, lead, earth, or glasse (of which I have known some made) but is so porous and spungy of its own nature, (as also by other accidents) besides what is received in with the water it self, by reason of its porousnesse, and also the piercing insinuating quality of the Air, the Air being so subtil, and of so peirceing and searching a nature, the *Machine* like wise pulling or sucking with that violence, that it will not hold to a much greater proportion; The lesse porous, and more fixed close and solid the materials are of which the Machines are made, the higher it will draw, but not to exceed that height, I am sure not much above. Secondly the descent must be very convenient, not too remote from the water, and it should have his fall in one reclining ground, and not by several parcels, let our mineralists expect no better from this instrument.

The more Artificial instruments have been commonly water wheels, which are of many sorts, made into fashions varying, according to their receiving their charge of water, some called under shot, which receive their charge below the Semidiameter of the wheel; And these have either open Ladles or close Buckets; the first can move quickest, but spend infinite of water: yet they have this property, that they will goe better in an high water or floods, without dragging or checking with the back water, than closer bucketted wheels: They are used in tide waters and in great Rivers, (by making the Ladles long and narrow) where more water, than fall can be had. The close bucketted wheels spend lesse water, and they are of three sorts, the close bucketted under shot, which receive their charge below, the over shot, and the elbow bucketted, overshot, breast and ground which is the best; receiving from above his water, yet upon the contrary side, which makes him not so much checked with the water, but that

it runs away with him. Some make these water wheels (not only as Instruments whereby to effect the motion) but likewise for self-raising the water, to the height almost of the Diameter of the wheel, by fixing round about upon the side of the Rimb little Buckets or Tankards (as some call them) that upon the wheel going round by force of the stream, the mouthes of these Tankards being placed with the going of the wheel, fill themselves at bottom, and likewise empty themselves again into a Trough when they come at the top, as the Bucket Gin doth; this is much used in diverse places for the floating of grounds, and it is excellent for that or any other purpose (as also the *Cochlea*, mentioned in the last Chapter of this Book) where the water is to be drawn not above 7 or 8 or 9 foot high, it is excellent likewise for drayning of Fens or Meeres of dead water.

The generall rules for all these wheels may be these, First, there is nothing to be gotten by the height of the wheel, but in the depth of the waters fall from the standing head, to the voiding tayl: For look how much bigger your wheel is, so much longer it is a going about, but how much greater your fall is, so much lesser water you shall spend to move your work. Therefore are wheels generally made large to receive this great fall: if their bigneſſe exceed their fall of water, they will then have more strength, but then what is this way gained in strength is lost in time, what you gain in the hundred you lose in the shear. If you make them much lesse, the violence of the fall of the water will be such, that it will not be contained in the Buckets, but be lost. I shall not for the present further trouble you about this, they being so commonly used, seeing likewise there are many exquisite workmen, as Mill-wrights, &c. which can contrive these wheels for the best advantage. See before of it in the first Part.

CHAP. II.

Of the various Species, or differing kinds of Water Gins, and wayes for Drawing of water.

THe first, best, and sureſt (if the Mine be worth it) of all other, is the Addit, Sough, or Shore, as some call it, where it may be obtained, but where they cannot be had, we must be compelled to use other Artificial wayes and meanes for to force up the water.

The *Machins*, or *Instruments* wherein *waters* are raised from lower Deeps, are for their *various forms* innumerable; but for their distinct kinds and sorts, but few.

The *world* hath laboured more to have them differing in *figures*, *forms* and *shapes*, than in effects or service; rashly supposing, that if the *Water-Gins* and *Machins* were but of a strange contrivance, and a sort, never yet (for what they knew of) experienced (though it may be others have long since tried them, as I know some have been of very late, and also of very chargeable tryals) presently, greater service must needs be expected and performed by them.

Most men have expected greater matters from the water-Gins, than can ever be effected, supposing that as they can take water from below, so they should alter the nature as well as place of the water, by making a grave and heavy body, (instantly) to be of no burden (thinking as it were, with smooth language, to court, and complement up that solid and weighty body) and so indeed have laboured much for a difficult nothing; whereas it is never to be hoped for by any experienced sober men, that water should become lesse of burden than his own natural weight. And this is the utmost power, and greatest excellency of *Water-Gins*, to occasion but only the pure weight of water, and no more, to be lifted, in an apt, convenient, and durable way: the rest of the ease must come from the powerfulnesse, and cheapnesse

of

of the efficient Movers, and prime commanders, or power moving.

The Inſtruments that tend to this *purpoſe* are (ſpecially) of two kinds; either ſuch as *roughly compel* and force the ſurly water to *aſcend*, or elſe they are ſuch as *fairly intreat*, and tacitly court the water *upwards*, by giving it a place wherein to fall (farther, and ſo) higher.

Of theſe Gins which compel and force the riſing of the water, ſome carry it with them, ſome draw it after them, others ſend it before them, and ſome do all theſe wayes raiſe the water.

The firſt ſort are commonly called *Bucket-Gins*; The ſecond *ſucking-pumps*; The third ſort *forcers* or bellows-Gin; the other are commonly called *chain-pumps*.

And in this order we ſhall treat of them in the remainder of this diſcourſe.

CHAP. 3.

Of Bucket-Gins which carry the water with them.

THe *Bucket-gin* is the moſt antient *Inſtrument* for water drawing (in an Artificial way) that I know of in the *World*; And there be infinite ſorts of them, diſpoſed in faſhions and ſhapes according to the pleaſure of the *Artiſt*, and the place requiring; Some of theſe are made only of ſtrong *Leather*, like bags, and are convenient for great *depths*, and ſmall *waters*, as crooked and narrow pits.

The commoneſt are made of wood, like unto water *payls*, or *trunks* for ordinary wells, ſome like Barrels, and thence are called Barrel-Gins, ſo equally hung in a bale of iron, that they receive and deliver their *charge* in the turn of a *hand*; yet not without ſome little help: Theſe are in many works drawn up with Horſes or Oxen very eaſily, for

for indeed, they have to do herein with little more than the pure *weight* of *water*: Only in regard the Horses are so oft put to change their *goings* by running backwards, and thereby many Horses cannot well be employed in one *Machine*, so that also much attendance of men is required for little doings, they are not therefore so acceptable, as another work something of this nature, which some do call the bucket work and bucket-gin, others the *Scotch-gin*, in regard it hath been practised much by Scotchmen, and used much about *Newcastle*, there are likewise several forms and fashions of them, according to the several fancies of men, but all to the same purpose. It consists of many single *Buckets*, hanging one under the other, between two chains with long lengths, working upon a *Rag-wheel*, so as that the *Buckets* be not bruised thereby in their *delivery* of their water, on the farther side of their wheel, and every one taketh his water up, in his turn, at lower end; for which purpose every Bucket hath an Air clack placed in the bottom, otherwayes it will not receive the water in, but come up almost empty; This is one manner of them.

Others hang them between two chains (as before) but make them to deliver their charge of water before they come over, or to the Rag wheel, equally poysing their Buckets (as before the Barrels, in the Barrel-gin) by means of a long Iron pin which goeth thorow the middle of them, as also thorow an hollow quill of wood, both ends of which Iron pin goeth into the chain at both ends, which ends (resting upon the Rag-wheel) bear by turns the whole weight of the water and work, and also saves the buckets from bruising; they are made likewise to turn out their water, by means of an Iron catch, at the Cestern or Trough, that taketh hold of them, and turneth them aside in going up, and so causeth them to deliver their water into the Trough; These Buckets are made sometime as the barrels, some of strong Leather, others of boards nayled together.

In *Turky* and *Egypt* (as I am informed) for the drawing

ing the water of *Nilus* where it doth not naturally overflow, as also in *Portugal* to water their Gardens & in divers parts beyond the Seas, they make this Gin, with earthen pots (with little holes in their bottoms) tyed one under the other, and linked together only with ropes instead of chains, and give it motion by means of an Asse in a tread-wheel. It is held by some to be the best the world useth for great depths to be brought up at one length, it must then be used but for a weak water, otherwayes not, for this Gin must not goe too violent a pace, but must rather (to deliver much water) have larger Buckets, to contain a great quantity of water, which quantity will be of great weight, and so consequently much subject to fractions, if the draught be too high, as is too often found to the great prejudice and hinderance of our Mineralists.

CHAP. 4.

Of Sucking Pumps.

THese drawing Gins which we commonly call *sucking pumps*, which draw the water after them, I take to be next of *Antiquity*; These aref ramed after divers fashions, double and single, or otherwise according as the *Artist* pleaseth, to *move* them, or to *multiply* them.

They all agree in this, that the *Barrel* or uppermost part wherein the *Bucket* worketh, must be greater than the part below the Bucket (wherein the water ascends) by two or three parts, as of a fower above a two below.

Secondly, if you draw herewith your water above ten or twelve yards, your *Bucket* must be let down (by an iron or wooden rod) into the Pump; For otherwise the water will not follow after, though you suck never so strongly, and *sucker* it never so closely, either for number, or nature of *suckers*. The reasons have been formerly delivered in the fire-Gin, as also in the Syphon or Philosophers Gin.

But by placing down the *Rod* within eight or nine yards of the bottom, you may draw water with this Gin as high as with any other in the world; The deeper you let fall your *Bucket*, the easier it will go, and not so soon subject to be out of order; it is much better to lift a foot of water than suck or draw a foot; The want of these practices (either through the *ignorance* or *wilfulnesse* of workmen) hath caused much failing, both to the discredit of *Machins*, as also of the workmen erecting them.

Chap. 5.

Of Forcers and their several kinds.

Forcers which send the water before them, are chiefly of three sorts, *Thrusting*, *lifting*, and *shoving Forcers*.

The first have their Buckets moving *perpendicularly* down, the second directly upward, the third moveth Horizontally forward; But these come near all to one in their ease; the first two being the best, and most natural & genuine; for their *moving strength* in all of them must be answerable to the quantity of water in the greater Barrels, and not as it is in the lesser *Pipes*, above the Buckets in which it ascends, nay the nearer that Pipe commeth to the bignesse of the Barrel though of equal bignesse or more larger, it is not the more heavie, the ignorance whereof hath caused much failing, but if it be too *streight* and *narrow* it goeth extream hard, which many having attempted to do (thinking thereby to have the lesse *weight* of *water* upon the Bucket) but they shall and have found, that the *forceing* and *crowding* of the *water* contrary to its own natural *porousnesse*, and as I may

may properly term it (as it were) a *wyer-drawing* of the *water*, addeth much more to the *heavier going* of this *Machine*, than if it had been of a far greater *bore*.

That water will be *contracted* and *crowded* (by force and violence) and made (as it were) more *ſolid* from its *porouſneſſe*, I ſhall here ſhew you a clear *demonſtration*.

If you fill a hollow *braſſe or leaden Ball* full of water, which Globous round form being of all other of greateſt *Capacity*; then cloſe ſtopping the hole, if you with a *hammer* beat or *cruſh* this *Bal* into a flatter *form* and *faſhion*, which *figure* is of farr leſſe *Capacity* than the other, which notwithſtanding containeth all the *water* in the former *Globe*; which could not be therein *contained*, but that the water being (by violence) made more *compact* and *ſolid*, lyeth in far leſſe *room* in the *flat* than it did in the *round figure*, neither is the weight diminiſhed.

Theſe *Gins* are uſefull eſpecially for narrow crooked places, wherein ſtreight Gins cannot conveniently work and are therefore for their faſhions to be framed according to their *place* permitting the motion; Theſe Machins alſo are very apt to be ſludged, and therefore beſt for clear water.

The *Motion* of theſe *Gins*, being not truly *circular*, they are not ſo profitably wrought upon by *men* or *horſes*; as hath been formerly noted. But wind or water will over-power them, and ſcorn their ſurly *ſhoggings*; they will force up water almoſt to any height.

CHAP. 6.

Of Chain-Pumps.

THeſe *Chain-Pumps* being ſo commonly made, and ſo generally practiſed, eſpecially in many great *works*, that I ſhall ſay but little of them, let them ſtand perpendicular, they will draw a good water a great height, ſome 10. or 12. fathom high or more, they will not ſludge as the other,

and therefore better for mineral affairs and muddy waters.

In this and in all other *Machins*, ſtrength is the life or *being* of a *motion*; and quickneſſe is the health or well-being of all water-*drawing*: neither is it ſo much to be conſidered how great or how large the Pump is, which let not be above five inches boar, as how faſt and nimble the *Chains* and *Suckers* aſcend. This Engine (as I conceive) may be brought to a higher perfection, than as yet I have ſeen it uſually made.

I now come to thoſe inſtruments which ſmoothly intreat and tacitly court the water upward, wherewith I ſhall conclude.

CHAP. 7.

Of Archimides Screw, Cochlea or Tun-Mills.

THe other Machins, ſpecifically differing from the former (by reaſon that the water aſcends therein with no direct compulſion) are the water *Screw-Gins* commonly called *Tun-Mills*.

Theſe Machins were invented firſt by *Archimedes*, written briefly of by *Cardanus*, and *Rivalt*, and moſt largely and ſubtilly by *Guido Ubaldus* in four books; but brought into ſome ſervice by the *Hollanders*, who have attained the *practice* of this *Engine*.

It is by ſome held to be the moſt abſolute of all water-Gins that move in an *Artificial* way, for it hath all the *excellencies* required on the behalf of the bearer, (*viz.*) *facility*, *perpetuity*, and *quantity*.

It bringeth up the water with as much *eaſe* as may be expected on the behalf of moving *Machins*, which commeth to paſſe (partly) by reaſon that the *motion* is *Gyral* upon a narrow *Center point*, moſt apt for *motion*, but chiefly, by reaſon that the water is not churliſhly *forced* up, but ſo kindly

kindly intreated, that it aſcends of it ſelf by labouring to deſcend, not that it taketh no ſtrength to move it, but ſo little as can be, which is no more than anſwereth to the meer weight of the water, and that in this, and all other *Inſtruments* (of this nature) muſt ever be expected.

The *Actings* of this *Machine* are in this reſpect moſt delightfull and raviſhing, to ſee thereby a *fourth* thing in *Nature*, become the child of Art, for as learned *Ubaldus* ſaith in his Preface to his books.

Vel Ars tantùm imitatur naturam, ut efficit pictura, vel ipſam coadjuvat, ut medicina, vel ipſam quoque ſuperat, ut in rebus Mechanicis apparet; ob ea verò quæ propoſuimus, nunc videtur mihi addere poſſe quartum: Nempe quod Ars aliquando decipiat, illudatque naturam ipſam, ſiquidem Ars efficit ut natura ſuos perducat effectus naturales, tamen ipſi contrarium accidat ejus, quod intendit, ut grave dum naturali motu deorſum tendit, ſurſum moveatur.

Art uſeth either to counterfeit Nature, as in paintings, or elſe to aſſiſt her, as in Phyſical Medicines, or otherwiſe to command her, as is ſeen in divers Ingines; But in this only which we now propound, it ſeems to me to be of power to effect a fourth prank, to wit, that Art can ſometimes cheat and cozen even Nature herſelf, for as much as Art ſo works that Nature may bring to paſſe her own proper ſervices, although ſomething falls out otherwayes than ſhee intended, even that a weighty *Element* while by its natural courſe it laboureth *downward*, is thereby raiſed *upward*; the reaſon hereof the ſame Author delivers in another place, ſaying,

Inſtrumentum nihil aliud efficere, niſi Aquæ præbere commoditatem ut ipſa deorſum fluì poſſit.

This *Inſtrument* doth nothing elſe, but afford *water* ſuch an advantage, as ſhee may thereby ſlide backwards. That there is no *compulſion* uſed herein is evidenced, even to common

common ſenſe, in that this *Inſtrument* raiſeth dry *weights*, *ſtones*, *gravel*, *mud and ſilth*, and whatſoever elſe is paſſable, as wel as fluid *water*; and hence ariſe h another excellency hereof, which is freedome from ſlight *marring* or *decayings*, for conſiſting only of *Wood* and ſome *Iron* compact together, as *boards* and *hoops*, being likewiſe for the bulk both *ſtrong* (if made in the beſt manner) and *light*, moving only the whole not parts, it becomes little leſſe decaying, than ſolid *timber*, and if it be truly and exactly framed for quantity of *water* it exceeds, and hath indeed been chiefly not ſo much in uſe, becauſe it only was too *large*, which made ſome indeavour the compoſing it in leſſer and better *forms* (which was accordingly effected) than formerly.

But that which moſt detracts from the univerſal excellencie of this *Machin* is, that they are but for little *heights* or *depths* (unleſſe placed one above another) and that they are not *placeable* in all *works*, and cannot be uſed without more ſpacious room, than can be had at eaſy rates in moſt places.

But for *water-houſes* that may be erected accordingly, it is conceived by ſome to be the only *Machin* (yet extant) both for eaſe and *quantity* of *water*, there having been *experimentally* added this perfection to their *practice*, that (one above another) they will raiſe *water* as high as any other *Gin*, all the aforeſaid excellencies holding alſo.

The experiment was of three *Cochleaes* or *water ſcrews* one above the other, moved with Cogg *wheels* and *trundles*, they drew eight or nine yards high, by the ſtrength of one *horſe*, and filled upon a *levell*, a ſix inch ſquare *lauder* or trough.

Thus haſt thou here delivered unto thee, the ſhadow of that which ſpent much *ſubſtance*, and by hewing thorow the *rocks* of difficulty, induſtry, great pains and expence, thou haſt for nothing ſhewed thee that (as ſhort as it is) which if formerly had been known to ſome, would have ſaved the *expence* of many thouſands of pounds.

6. I had thought to have enlarged some *Chapters*, as also to have shewn, for the advancement of the *mineral world*, wherein consisteth the *hazzard*, uncertainty and *Certainty* of these affairs, what it is that maketh some so much to *gain*, others so extreamly to *lose*, as also to declare some wayes and means, whereby a good *estimate* might be given (before much mony spent) whether there will be *gain* or *losse*, as also the *posture*, situation, manner of getting and working of them, all which are convenient to be understood, as much conducing to the better designing and ordering of things, for the best advantage and profit of the work.

I had thoughts likewise to have discoursed of some other *wayes* and *Machins* (for the more facil drawing of *water* out of *deeps*) and not as yet to my knowledge, known and *practised*, and (as I conceive) as good or much better than any used and *practised*; and such (as I hope) will endure the *test* of all principles, as also the approbation and *censures* likewise of those most judicious and *critical spirits*, that pretend to most *speculative* and *practical* knowlegde that way.

I know for these lines I shall be accused (as some already have done, which hath enforced these last lines from me) of extream *immodesty*, *ostentation* and *confidence*, that I should take upon me to know so much or more than others of much greater *Antiquity* and *abilities* than my self, especially in such a way that hath proved to many so fatal. Let such know

Qui se dicit scire quod nescit temerarius est, et qui negat scire quod scit ingratus est.

7. Let them likewise consider, that no man knoweth all things; put the most knowing mans *Knowledge* in one *Scale*, his *Ignorance* in the other, his *Ignorance* will much over *ballance* his *Knowledge*; why may not therefore some (who have *industriously* sought and applyed themselves more

more to one way than another, know more than others in that *particular way*? It is the opportunity, *advantage* and height of a place, and not ſo much the long looking, that diſcovereth the *proſpect*; he that hath been but once on a *Turret*, hath ſeen more of a *City* or *Country*, than he that hath lived but in one *Street* all his life. Beſides, in *ſearching*, why may not one find out that (yet not know more for *quantity*, nor ſo much by farr) which others, who have endeavoured that way, have not? whether it be ſo or no, they deſire to be but as an *Informer*, not a *Iudge*. One ſound *experiment* ought to be of a greater *convincing force*, than a *million* of contradicting votes, fond opinions and imaginations.

Beſides, we may obſerve, that thoſe things or wayes that are not in he *Common road*, and which are cryed down by the more general *opinion*, men do for the moſt part reſt themſelves in a *ſuperficial* knowledge of them, as they ſeem at the firſt appearance, ſo that they ſeldome or never ſearch to the *depth* nor *root* of them, vulgar ſpitits generally meaſuring things only by the *skin* and *outſide*, but do not, nor will not comprehend them according to their natural and *genuine grounds*, believing ſtill, that *Iuſtice* and *Prudence* are alwayes on that ſide *Fortune* is of.

However, I ſhall not be *peremptory* in it, I having not made ſo ſatisfactory a *tryal* of it as I intended and deſired, (ſuſpend therefore I pray thee thy cenſures) which make me for the preſent to forbear any farther diſcourſe of it.

8. I muſt confeſſe at the firſt (I having no *experience* nor *knowledge* that way, but was wholly to be guided by the *reading*, (for I cannot well call it *experience*) of another) I received a foyl, not yet recovered, by reaſon of ſome præpoſterous *inconſiderate* abrupt violence (as I may call it) uſed to me, together with ſome other *collateral accidents* in relation to the times, which otherwayes I might *plentifully* have redeemed, which did ſo perplex and tranſport me, and likewiſe ſo *unſatisfie me* in point of knowledge and *experience*, that I was (as it were) enforced

(though

(though the *Steed* was ſtollen) leaving other *ſtudies*, to apply my ſelf to that; I did then, ſeeing I was entred into the *liſts* my ſelfe uſe no ſmall diligence and *expenſive* indeavours (for a long ſeaſon together and with what privacy I could) both *ſpeculative* and *practical* (though through infinite *diſcouragements*, *obloquies*, and *anxieties*) to attain to ſome underſtanding in it; as alſo I endeavouted to find out and diſcover what *fallacies* and *deluſions* (there being many) I could: I accordingly have dealt *ingennouſly* with thee in theſe lines, by acquainting thee with them, where the tryals have been *compleated*; though it may be thou wilt not credit me, but thou ſhalt really ſo find them when ever thou tryeſt.

I was the more encouraged alſo in theſe wayes, conſidering that it was not only much for a *publick good*, but likewiſe it hath been much for the *private profit* of many (though not of all) as alſo that it is *honeſt*, *lawfull*, and *neceſſary*, and not *diſhonourable*; many able, wiſe men, both of the *Nobility* and *Gentry*, and likewiſe Eminent *Scholars* having much applyed themſelves, and *adventured* in theſe affairs. Conſidering likewiſe that all above ground ſeems to be little enough, and too little I doubt, for the *Harpies* of this age. All which conſiderations did then much further animate me to look *under ground*, to ſee, if poſſibly there might be found an honeſt, as alſo a certain profit in ſo great *Chymeraes* and *uncertainties* as they are generally ſo eſteemed.

I ſhould have ſaid ſomething concerning the abovesaid *particulars*, but in regard of ſome years *diſcontinuance* from theſe affairs, by reaſon of an *indiſpoſition* of health; I having likewiſe in the *interim* looked into other *Studies*; as alſo by reaſon of the abſence of ſome *papers*, together with theſe *diſtracted* times, I muſt for the preſent therefore lay it aſide, until a more convenient time.

F I N I S.